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DNA Optical Support Program Summary for 1989

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Technical Report

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13. ABSTRACT *(Maximum 200 words)*

This annual report summarizes the technical work performed for the Defense Nuclear Agency by Technology International Corporation during the 1989 calendar year. Under the DNA contract TIC expended most of the year's effort in the planning and preparation of the ground optics instrumentation planned for use on the DNA/GL EXCEDE III upper atmospheric research experiment scheduled for the spring of 1990. A summary of this effort, the resulting instrument plan, and the completion status of the optical instrumentation are contained in this report. During this same period, TIC continued to provide data, measurements, and data film copies to the DNA scientific community from the TIC combined DNA, NASA, GL, and other agency film record data base relating to atmospheric effects topics.

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Conversion Table

(Conversion factors for U.S. customary to metric (SI) units of measurement)

To Convert From	To	Multiply By
angstrom	meters (m)	1.000 000 x E-10
atmosphere (normal)	kilo pascal (kPa)	1.013 25 x E+2
bar	kilo pascal (kPa)	1.000 000 x E+2
barn	meter^2 (m^2)	1.000 000 x E-28
British thermal unit (thermochemical)	joule (J)	1.054 350 x E+3
cal (thermochemical)/cm^2	mega joule/m^2 (MJ/m^2)	4.184 000 x E-2
calorie (thermochemical)	joule (J)	4.184 000
calorie (thermochemical)/g	joule per kilogram (J/kg)	4.184 000 x E+3
curie	giga becquerel (GBq)	3.700 000 x E+1
degree Celsius	degree kelvin (K)	$t_K = t_C + 273.15$
degree (angle)	radian (rad)	1.745 329 x E-2
degree Fahrenheit	degree kelvin (K)	$t_K = (t_F + 459.67)/1.8$
electron volt	joule (J)	1.602 19 x E-19
erg	joule (J)	1.000 000 x E-7
erg/second	watt (W)	1.000 000 x E-7
foot	meter (m)	3.048 000 x E-1
foot-pound-force	joule (J)	1.355 818
gallon (U.S. liquid)	meter^3 (m^3)	3.785 412 x E-3
inch	meter (m)	2.540 000 x E-2
jerk	joule (J)	1.000 000 x E+9
joule/kilogram (J/kg) (radiation dose absorbed)	gray (Gy)	1.000 000
kilotons	terajoules	4.183
kip (1000 lbf)	newton (N)	4.448 222 x E+3
kip/inch^2 (ksi)	kilo pascal (kPa)	6.894 757 x E+3
ktap	newton-second/m^2 ($N\text{-}s/m^2$)	1.000 000 x E+2
micron	meter (m)	1.000 000 x E-6

Conversion Table (Concluded)

To Convert From	To	Multiply By
mil	meter (m)	2.540 000 x E-5
mile (international)	meter (m)	1.609 344 x E+3
ounce	kilogram (kg)	2.834 952 x E-2
pound-force (lbf avoirdupois)	newton (N)	4.448 222
pound-force inch	newton-meter (N•m)	1.129 848 x E-1
pound-force/inch	newton/meter (N/m)	1.751 268 x E+2
pound-force/foot^2	kilo pascal (kPa)	4.788 026 x E-2
pound-force/inch^2 (psi)	kilo pascal (kPa)	6.894 757
pound-mass (lbm avoirdupois)	kilogram (kg)	4.535 924 x E-1
pound-mass-foot^2 (moment of inertia)	kilogram-meter^2 (kg•m^2)	4.214 011 x E-2
pound-mass/foot^3	kilogram-meter^3 (kg/m^3)	1.601 846 x E+1
rad (radiation dose absorbed)	gray (Gy)	1.000 000 x E-2
roentgen	coulomb/kilogram (C/kg)	2.579 760 x E-4
shake	second (s)	1.000 000 x E-8
slug	kilogram (kg)	1.459 390 x E+1
torr (mm Hg, 0°C)	kilo pascal (kPa)	1.333 22 x E-1

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SECTION 1

INTRODUCTION

As an integral part of the extended Defense Nuclear Agency (DNA) Atmospheric Effects Sensor Operability Program (AESOP), Technology International Corporation (TIC) has continued to provide optical measurements support to DNA and the DNA scientific contractor community throughout 1989. This approximately one man year effort consisted primarily of final planning and preparation for the DNA/Geophysics Laboratory (GL) EXCEDE III upper atmospheric field experiment at the White Sands Missile Range, New Mexico; and, as necessary, the provision of DNA optical data base information to DNA and GL contractors for their respective planning requirements throughout the year. The EXCEDE III instrumentation preparation effort was supported in part by the Utah State University (USU) Space Dynamics Laboratory during this period.

The EXCEDE III experiment was designed to quantitatively measure the optical emissions associated with the collisional excitations of the upper atmosphere by a rocket borne electron beam accelerator. Observations of the real time and decaying emissions brightness and spectral characteristics will be analyzed to provide data on the atmospheric composition and reaction/rates of the beam excited species. In support of the overall experiment diagnostic effort, TIC will instrument and operate multiple ground optics sites at selected locations on the White Sands Missile Range for the EXCEDE III program. This report details the work by TIC in preparing the optical instrumentation, camera mounts, electronic control equipment, and the three instrumentation vans which are to be sent to the range approximately 6 weeks before the scheduled experiment.

TIC also provided specific data and related information to the DNA and GL scientific community during the 1989 period covered by this report. Most of this data related to upper atmospheric and chemical reactions while some related to information regarding past nuclear test data.

By November 1989 a sufficient number of EXCEDE instrumentation systems had reached completion so that TIC was able to hold an open house for the DNA and GL EXCEDE community to review the ground optics program and the completed instrumentation. Over a dozen camera, TV, and intensifier systems were displayed and a presentation was given by TIC as to the planned deployment and operation of this equipment. Video data records of the PRECEDE I experiment recorded by TIC from the WSMR Denver site were also presented to the group.

SECTION 2

EXCEDE III PLANNING AND COORDINATION

The basic objective of the TIC ground optics program is to record the spatial, radiance, and spectral characteristics of the electron beam excited atmosphere as a function of time in order to provide data from which the collisional region emission profiles, dosing symmetry, and decay emission structure history parameters could be analytically derived. Based upon past experience by TIC in recording electron beam induced emission histories, multiple optical site locations are planned at the White Sands Missile Range test area to collect sufficient data to achieve this objective.

The two experimental objectives of the ground optics measurements are to record the individual field aligned pulse images (for as much as the 4.7 second pulse duration) with the pulse continually sweeping across the sky and, to record the decay emissions structure of the excited fixed region of space immediately after the colliding electron beam has passed through that region. Because of the very weak apparent beam (and therefore decay emission) brightness anticipated (except when viewing the beam into the magnetic zenith), the ground based optics must record the atmospheric emissions with optically fast systems in general and with long integration times (seconds) for film cameras or using intensified film cameras for shorter exposures with the attendant loss in resolution and background region discrimination.

In order to integrate an exposure of the moving beam object an accurate tracking mount will be required. Moreover, in order to record the fixed position residual excited air either intensified short exposure tracking cameras or fixed long exposure staring cameras must be employed. (The latter can be non-shuttered if necessary to accomodate

special fast lenses). In general the intensified camera systems will be --for practical reasons-- limited to smaller fields of view and less overall object source resolution for a given focal length objective when compared to the film camera system.

The EXCEDE III ground optics instrumentation will be considered as belonging to one of two basic groups or categories of instrumentation: that of recording the beam-on sweeping instantaneous atmospheric image, and that of recording the fixed in space decaying atmospheric region just previously dosed by the electron beam collisional interaction. Certainly overlap in the data obtained by systems in each category will exist to varying degrees. In addition to these specific dedicated instrumentation categories there will be real time (intensified) video coverage of both the beam-on and decaying atmosphere emissions as well as ballistic (single, fixed frame) camera systems to record the whole or major portions of the excited regions along the trajectory arc. The optical coverage categories can be summarized as follows:

OBJECT	PRIMARY COVERAGE	SECONDARY COVERAGE
Beam-On	Tracking Camera - Film (NFOV) - Video (NFOV)	Tracking Camera - Intensified (NFOV)
Beam-Off	Fixed Camera - Film (MFOV) - Vidoe (MFOV)	Fixed Camera - Intensified (MFOV)
Late Time Trail/Effects	Trainable Camera - Film (MFOV) - Video (MFOV)	Trainable Camera - Intensified (MFOV)
Trajectory	Fixed Camera - Film (WFOV)	

NOTE: NFOV = Narrow Field of View (5 - 10°)
MFOV = Moderate Field of View (10 - 25°)
WFOV = Wide Field of View (40 - 60°)

A wide variety of faint phenomena optical instrumentation and components has been assembled by TIC for the EXCEDE III field program experiment. This instrumentation is centered about the fast lens systems which will be required to record the faint phenomena characteristics of the beam excited atmosphere. The lenses obtained fall into the following specification categories:

f/no. Range	Focal Length Range	Field of View Range
f/0.87 - f/0.95	76mm - 150mm	25° - 30°
f/0.90 - f/1.2	300mm - 414mm	5° - 7°
f/1.3 - f/1.5	230mm - 250mm	15° - 20°

Adapting such fast (large aperture) optics to suitable recording camera systems is generally difficult at best and accounts for much of the engineering development effort described subsequently with respect to camera, video, and intensified system instrumentation.

Over and above the planning and development concepts related to the ground optics instrumentation a significant portion of the overall planning and field experiment coordination effort was related to the determination of the best ground based geographical site locations for recording the electron beam excitation geometry and associated characteristics, the availability and access to such sites, and the logistical considerations and requirements to establish a working optics site for the field experiment period.

As a consequence of reviewing the above parameters and coordination during several TIC site surveys prior to and during 1989, several sites were chosen in and around the White Sands experiment trajectory profile. Although this group was to be reduced to a few selected sites for reasons of feasibility the total list of those sites considered i ·resented here

for future review in the event the EXCEDE experiment or similar experiment is conducted again.

SITE	LOCATION	DESCRIPTION	COMMENTS
TIFF	North, in magnetic meridian	Good viewing location No power, no phone, good access (gravel 1 1/2 mile), no building facilities	Possibility for spectral measurements
RUSS	NE of magnetic meridian trajectory	Good viewing location Power, phone, comm. available, access good	Altermate Primary
RIM FIRE	NE of magnetic meridian	MIT/LL Experimental Test Site (ETS). Available on invited basis only. Power, phone, comm., Building 300 pass data line available*	Primary Site
COWAN	Orthogonal (East) to magnetic meridian trajectory site	Remote site, no lights, power, phone, comm. lines available, building available, access good	Primary Site
NASA WELL	SE of magnetic meridian trajectory	Remote site; power, phone lines close enough for drop, no building facilities	Alternate Primary
Upham	Off range, South on magnetic meridian trajectory	Remote private ranch land, Power, phone lines reasonably close by	Good Alternate for Spectral Measurements

* Building 300 (WSMR) generates tracking look angles for all remote sites at WSMR.

In summary it should be pointed out that whereas it was originally conceived that the EXCEDE III ground optics measurements would be conducted similarly to the PRECEDE I experiment in terms of scope and site location, the concept was expanded considerably over the course

of planning for the current experiment. The very successful PRECEDE I optical coverage by TIC was based upon recording beam-on images primarily from a side viewing perspective using film and video camera systems. Additionally a fixed pulse camera was located near the magnetic meridian plane to record any residual atmospheric decay emission throughout the experiment and thereafter. In contrast, the EXCEDE III optical coverage, while including tracked film and video coverage also incorporates staring camera systems, ballistic camera systems (both in and orthogonal to the magnetic meridian trajectory plane), and, ballistic spectral and intensified pulse spectral camera systems in order to record the gross energy distribution during the electron beam excitation phase of the experiment as a function of altitude between 90km and 120km during the flight.

SECTION 3

EXCEDE III OPTICAL SYSTEM ENGINEERING DEVELOPMENT

The major portion of the EXCEDE III planning and preparation effort covered by this report was expended in the design, engineering, and development of the highly sensitive optical camera systems, camera mounts and adaptors, and the associated control and support equipment required to operate the optical instrumentation in the field environment. A discussion of these development efforts can be conveniently presented as a function of the individual categories although, generally speaking, considerable iterative interfacing was required throughout the fabrication and build up of the various camera components and mount systems to be described. The various instrumentation systems are to ultimately be deployed on a wide array of tracking, trainable, and fixed-adjustable mounts which will be provided by WSMR, MIT/Lincoln Laboratory ETS, and the remainder by TIC.

3.1 INSTRUMENTATION SYSTEMS

As a result of the general optical coverage requirements derived by TIC and the GL EXCEDE Science Planning Committee, an array of some twenty camera systems were decided as being appropriate for deployment among several primary and secondary sites at the White Sands Missile Range. The most extensive instrumentation effort was the development of the beam recording systems which need to be tracked to obtain sufficiently integrated film exposures to record the faint extent of the beam at the higher altitudes of the beam payload trajectory. These systems, requiring remote operation capability, are the most difficult to construct because of the inherent limitations in adapting f/1 optics to typical film camera instrumentation. By judicial matching of the optical/mechanical characteristics of the complement of lenses and instrumentation cameras available for the EXCEDE project a number of

systems were built up and tested for performance.

In general the build up effort included the modification of pulse cameras to optimize film plane flatness; the mechanical modification of video cameras to accept f/1 type optics (in some instances the optical modification of the lens to adapt to the video tube target); the incorporation of light intensifiers with relay optics to fast objective lens systems; and the necessary engineering to permit remote electrical operation of these systems while incorporating mechanisms to adjust and maintain focus of the lens-camera assembly under field environmental conditions.

Other camera instrumentation systems were built up from available or acquired components to provide for coverage of the decay emissions and other possible late time phenomena of interest to the EXCEDE scientific community. These (relatively) wide angle systems were to be fixed in some cases and repointed at late times to cover phenomena of interest when required. Although these systems incorporated f/1 optics the fact that they were of a less exotic geometry than the long focal optics permitted a less difficult engineering approach to developing these camera systems.

Appendix A presents the revised EXCEDE III instrument plan summarizing the camera systems planned for deployment at the several WSMR optical site locations. Also included in this plan are ballistic cameras to record the payload flight trajectory from both meridian and orthogonal viewing sites. It will be noted that several cameras systems also have transmission grating foreoptics added. This is an attempt to at least qualitatively determine the atmospheric emission energy distribution during the several phases of the beam cycle over the

altitude regime of the experiment.

The incorporation of spectral transmission gratings in the overall EXCEDE ground optics plan was a result of recommendations by the GL Science Committee to this effect and the fact that TIC was able to acquire several large aperture gratings for the term of the experiment. The gratings available for the EXCEDE experiment are listed in table 1 showing the blank diameter and the ruled grating area with respect to the number of grooves and effective blaze angle for photographic imaging application. The relatively large blank diameter permitted the efficient adaptation of these gratings to six and eight inch lens apertures on the ground optics instrumentation.

3.2 OPTICAL MOUNT SYSTEMS

In order to properly support, track, and accurately aim the extensive complement of TIC EXCEDE III ground optics instrumentation at the remote WSMR optics sites, a wide variety of mount types will be required. These mounts will either be provided by TIC or by the WSMR range installations in which case TIC will be responsible for providing the necessary structural adaptors to fit the instrumentation to the mounts.

The optical mount requirements can be broken down into three basic categories corresponding to the phenomenological coverage requirements discussed in section 1. These basic types are as follows:

A. Tracking. Optical mount aiming is achieved by use of radar tracking data of the payload, processed with respect to the

Table 1. Optical transmission grating availability - 1989.

No.	Blank	Ruled Area	Grooves	Blaze Angle *
1.	210mm Dia	160mm x 210mm	150 l/mm	9.8°
2.	160mm Dia	110mm x 110mm	75 l/mm	2.35°
3.	160mm Dia	110mm x 110mm	300 l/mm	9.2°
4.	160mm Dia	110mm x 110mm	75 l/mm	2.3°
5.	160mm Dia	110mm x 110mm	300 l/mm	9.3°

* Measured from zero order to Hg 5461 Å green line

geodetic coordinates of the optical site, and passed to the mount signal processor at the particular site.

B. Trainable. Trainable mounts are manually operated so as to repoint from nominal to newly defined look angles determined by real time observations (e.g. TV) or target location prediction upgrade after launch.

C. Fixed-Adjustable. The fixed type mount is utilized for applications wherein the predicted pre-event pointing angles are not to be changed during the experiment.

In each instance consideration must be given to the instrumentation weight and balance, the mount azimuth and elevation adjustment latitude, the degree of pointing accuracy, and subsequent pointing recalibration prior to the experiment. (It is also necessary to consider whether terrestrial or celestial pointing references --or both-- are to be used in the set up and reference check operations).

After reviewing the general experimental requirements for the EXCEDE ground optics coverage a mount plan was arrived at with the aid and assistance of MIT/Lincoln Laboratory and the WSMR optics group. The mount types to be deployed are summarized in table 2.

In both the MIT/LL and the WSMR situations, TIC will provide the necessary frame adaptors to accomodate the TIC instrumentation to the respective mount types. In the MIT case adaptors for two camera systems will be required. For the WSMR VTM (Versatile Tracking Mount) mounts, however, a total of six upper base mount adaptors and six lower mount adaptor frames will be required. The latter represents a significant effort as part of the engineering preparation of the field

Table 2. EXCEDE ground optics mount type summary.

	Type	Source	Model	Operation	Qty	Location	Specifications
1.	Tracking	MIT/LL	Equatorial Telescope	radar controlled	(2)	meridian view	3 cameras 1^{o}/sec $360^{o}/90^{o}$
2.	Tracking	WSMR	Az/El	radar controlled	(3)	(1) meridian (2) orthogonal	4 cameras 30^{o}/sec $360^{o}/90^{o}$
3.	Trainable	TIC	Cine Theodolite	manual	(2)	(1) meridian (1) orthogonal	2 cameras $360^{o}/70^{o}$ $\pm 0.1^{o}$
4.	Fixed-Adjustable (Az/El)	TIC	Ballistic Theodolite	---	(2)	meridian	1 camera $360^{o}/80^{o}$ $\pm 0.01^{o}$
5.	Fixed-Adjustable (Az)	TIC	Modified Theodolite	---	(3)	(1) meridian (2) orthogonal	1 camera 360^{o}/--- $\pm 0.1^{o}$
6.	Fixed	TIC	---	---	(7)	(5) meridian (2) orthogonal	1 camera $180^{o}/90^{o}$ $\pm 1.0^{o}$

instrumentation.

Both the cine theodolite mount and ballistic theodolite mount types adapted for the EXCEDE III experiment also entailed a significant engineering effort during the 1989 preparation phase. In each instance, including also the modified theodolite types (item 5, table 2), the modifications entailed in adapting these mounts from their original restricted applications to the more general application for EXCEDE type field experiments embodied a significant technical effort for the seven mounts in this category, as did integrating the individual instrumentation to the respective mounts.

3.3 ELECTRONIC SUPPORT EQUIPMENT

A necessary part of the preparation of the ground optics instrumentation for the EXCEDE III field experiment was the construction or modification of electronic control and timing equipment required for this instrumentation. Each electrically operated camera system requires, typically, an individual camera control relay unit, a control distribution unit, a power unit, and a timing sequencer unit to trigger and advance the camera at the appropriate instant. A significant portion of the engineering development effort was expended in this sector to prepare the extensive number of such camera control systems distributed among the several planned stations. Additionally, new longer than normal power, control, and video cables had to be made in order to reach each camera on the multiple tracking mounts from the TIC supplied instrumentation vans at the respective remote optical sites.

In addition to the controllers, sequencers, and other TIC fabricated electronic units, a total of six video recorders, monitors, and video

date-time generators were put together as part of the electronic systems developed for the EXCEDE III experiment. These systems were incorporated into the instrumentation van configurations so as to provide real time monitoring of the electron beam function and cycle timing as well as after the fact records of the experiment with an accurate time base for date correlation and interpretation.

3.4 OTHER ENGINEERING SUPPORT

It was planned from the beginning that TIC would provide an appropriately configured optical instrumentation van at each primary remote optical site for the WSMR EXCEDE III experiment. The vans, in addition to providing a suitable shipping vehicle for the several thousand pounds of camera and support equipment, serve a number of required functions in connection with the field experiment. Housed in the vans are the power sources (120vac, 24vdc) for the instrumentation, the camera controllers and sequencers, and the video monitors and recording equipment. The vans also provide camera system assembly and check out facilities, darkroom loading space, and a focal point for site communications which will usually consist of one or more telephones, range count down net, project communications net, and rf receivers as may be appropriate to the operation.

A total of three TIC existing instrumentation vans have been reconfigured for the EXCEDE III ground optics field operations. These vans were first demoded from the previous project configuration and then reworked to suit the projected EXCEDE needs as described above. Based upon a contemplated spring experiment at WSMR the air conditioning units were not reinstalled in the vans saving a significant effort, space, and power requirements at the remote sites.

SECTION 4

EXCEDE III INSTRUMENTATION TESTING AND CALIBRATION

The planning and optical engineering design phase for the DNA/GL field experiment scheduled for spring 1990 reached an adequate state of completion for individual camera systems in 1989 such that testing of much of this equipment was able to be achieved during this period. Check out and testing procedures included attaining film plane flatness for a particular component configuration, electro-mechanical operation and framing/pulse rate, field focus capability, and, finally, mount integration and balance procedure.

Once a camera system had reached a nominally final assembly configuration, the camera (film, video, or intensified system) was calibrated through a night time focusing procedure using a star background to achieve infinity focus. Film systems were tested using film substrates similar to those planned for the field experiment and were tested as close as possible to the temperature environment expected under the anticipated field conditions. Both video and intensified systems were generally such that real time focusing was readily achievable except in a few instances where some intensified film cameras had to be focused as with normal film cameras and film chemically processed as part of the procedure in the laboratory and in the field.

Two opportunities occured during 1989 for field testing of some of the EXCEDE camera systems. The first was the NASA high altitude chemical release experiment over Fort Churchill, Canada in the spring of 1989. Several intensified camera systems and an intensified video system were tested on two separate chemical release experiments from an observing site west of Boston, Massachusetts in support of the NASA Goddard Space Flight Center research program. All of the camera

systems worked successfully but the use of ballistic theodolite mounts was found to be impractical for quick pointing angle changes during an active experiment and all such planned applications for the EXCEDE experiment were changed to the cine theodolite type mount.

A second opportunity to test some EXCEDE instrumentation during 1989 occurred at the MIT Lincoln Laboratory test facility at the White Sands Missile Range for the SDI/LANL Beam Aboard Rocket (BEAR) upper atmospheric neutral beam experiment. MIT operates several 31" tracking telescopes at this experimental test site and had, at the earlier request of TIC, coordinated the interfacing of the WSMR radar track pass data to provide range tracking capability for these telescopes.

TIC was able to test both a new intensified camera system and an intensified video camera system as part of the BEAR experiment. Adaptors for the MIT telescope were fabricated by TIC such that these mount adaptors could be used on the BEAR experiment as a test and subsequently in support of the EXCEDE experiment as part of the TIC ground optics measurements program at several WSMR sites.

The TIC instrumentation adapted to the MIT/LL mount functioned as planned but did not record any BEAR data due to cloud cover in the northern part of the range where the MIT observatory is located. Nonetheless the TIC interface with both the MIT tracking telescope system and the MIT-WSMR range protocol was clearly demonstrated to be of value for the forthcoming EXCEDE III operation.

By the end of the year long preparation effort twenty eight cameras and instrumentation systems had been completed and undergone functional tests. Appendix B summarized the status of this instrumentation as a

function of position number in the TIC EXCEDE project instrument plan (Appendix A). In some cases there remained further work to adapt the system to field use, to attain infinity focus, or, for example, to determine the proper intensifier gain for the type of film to be employed. Beyond this it still remained at this time to interface the systems to the respective mounts from which they would be operated.

APPENDIX A

EXCEDE III INSTRUMENT PLAN

TECHNOLOGY INTERNATIONAL CORPORATION

INSTRUMENT PLAN

OPERATION: EXCEDE III **DATE:** 16 - 30 April 1990 **STATION:** NASA WELL

EVENT: **LOCATION:** WSMR, NM **PROJ/ENGINEER:**

POSITION	INSTRUMENT	FOCAL LENGTH	FILTER	FILM	f/n	SHUTTER/RATE	REMARKS	MT
31	PO 9/BCE	9"		2484 Pan 70mm x 100'	1.5	5.3 sec int.	9.5×16.6^{o}	VTM-3
32	Kollmorgan-6/BCD	6"		2484 Pan 35mm x 150'	1.0	5.3 sec int.	9.5×13.7^{o}	VTM-3
33	MCP-6/N-2000 (50mm) (85mm)	6"	300 line Grating	2484 Pan 35mm x 50 expos	0.87	1 sec (1 sec)	9.4^{o} Dia	VTM-3
34	Cohu-4410 TV	3"		S-VHS T-120	0.87	1/30 sec	7×9.4^{o}	VTM-3
35	BCE 4.5	4.5"		2484 Pan 70mm x 100'	0.95	4, 8, (16) sec	25^{o} Dia	KTH-4
36	MCP-3/N-2000 (50mm) (50mm)	3"		2484 Pan 35mm x 50 expos	0.87	manual	19^{o} Dia	KTH-4
37	Farrand-6/Spectral	6"	75 line Grating	TXP 4 x 5" sheet	0.87	Ballistic (2 min)	30^{o} Dia	BC-2
38	K-6D	6"		TXP 5 x 7" sheet	2.8	Ballistic (4 min)	43×58^{o}	L

ADDITIONAL INFORMATION:

TECHNOLOGY INTERNATIONAL CORPORATION

INSTRUMENT PLAN

OPERATION: EXCEDE III　　DATE: 16 - 30 April 1990　　STATION: RIM FIRE (MIT/LL)

EVENT: 　　LOCATION: WSMR, NM　　PROJ/ENGINEER:

POSITION	INSTRUMENT	FOCAL LENGTH	FILTER	FILM	f/n	SHUTTER/RATE	REMARKS MT	
21	PE 9/GC	9"		2484 Pan 35mm x 150'	1.5	1 sec	4.6 x 6.2°	B-Mount
22	Cohu-4410	4.5"		S-VHS T-120	0.95	1/30 sec	4.7 x 6.3°	B-Mount
23	BCE 4.5	4.5"		2484 Pan 70mm x 100'	0.95	4, 8, (16) sec	25° Dia	KTH-3
24	MCP-3/N-2000 (50mm) (50mm)	3"		2484 Pan 35mm x 50 expos.	0.87	manual	19° Dia	KTH-3
25	Cohu-4410 TV	2"		S-VHS T-120	0.95	1/30 sec	10 x 14°	(KTH-3)
26	K-12W Spectral	12"	300 line Grating	SO-117 5 x 7" sheet	2.6	Ballistic (2 min)	22 x 31°	BC-1
27	K-12E	12"		SO-117 5 x 7" sheet	3.0	Ballistic (6 min)	22 x 31°	L
28R	K-3P #1	3"		SO-117 5 x 7" sheet	4.5	Ballistic (6 min)	77 x 97°	L
29R	K-6D	6"		SO-117 5 x 7" sheet	2.8	Ballistic (6 min)	43 x 58°	L

TECHNOLOGY INTERNATIONAL CORPORATION

INSTRUMENT PLAN

OPERATION: EXCEDE III **DATE:** 16 - 30 April 1990 **STATION:** COWAN SITE

EVENT: **LOCATION:** WSMR, NM **PROJ./ENGINEER:**

POSITION	INSTRUMENT	FOCAL LENGTH	FILTER	FILM	f/n	SHUTTER/RATE	REMARKS MT
01	Delft 300D	300mm		2484 Pan 70mm x 15'	0.9	5.3 sec int.	9^{o} Dia FOV VTM-1
02	Fairchild T-10R	250mm		2484 Pan 70mm x 100'	1.3	5.3 sec int.	11.4^{o}Dia VTM-1
03	TSI/FR-207	16.3"		2484 Pan	1.2	1sec(1/10sec)	5.5^{o}Dia VTM-2
04	Jonel/CA-120	80"		2253 EK 70mm x 100'	8	1 sec	$1.6x1.6^{o}$ VTM-2
05	MCP-4.5/FR-207 (50mm) (85mm)	4.5"		2484 Pan 35mm x 150'	0.95	1sec(1/10sec)	12.5^{o}Dia VTM-2
06	Cohu-4410 TV	3"		S-VHS T-120	0.87	1/30 sec	$7 x 9.4^{o}$ VTM-1
07	BCE-4.5	4.5"		2484 Pan 70mm x 100'	0.95	4, 8, (16)sec	25^{o}Dia KTH-1
08	MCP-3/N-2000 (50mm) (50mm)	3"		2484 Pan 35mm x 50 expos		Man. (1sec)	19^{o} KTH-1
09	Cohu-4410 TV	2"		VHS T-120	0.95	1/30 sec	$10 x 14^{o}$ (KTH-1)
10	Fairchild T-10 Spectral	250mm	150 line Grating	TXP 4 x 5" sheet	1.3	Ballistic (2 min)	20^{o}Dia KTH-2
11	K-6K	6"		TXP 5 x 7" sheet	2.5	Ballistic (6 min)	$43 x 58^{o}$ L

ADDITIONAL INFORMATION:

APPENDIX B

EXCEDE III GROUND OPTICS
INSTRUMENTATION STATUS
SUMMARY

EXCEDE III GROUND OPTICS STATUS

Cameras Completed and Functioning Mechanically

Camera Position	
01	Delft 300D Camera. Complete with base adaptors. (Req. boresight).
02	Fairchild T-10R Camera. Complete. (Req. 45^{o} base adaptor).
03	TSI (40mm Intensifier) Camera. Complete. (Req. new battery holder).
04	Jonel 80/CA-120 Camera. Complete. (Req. alignment).
05	MCP-4.5 (25mm Intensifier) Camera. Complete. (Req. int. install.).
06	Cohu 4410 TV Camera. (3" f.l.) (S-VHS) Complete; operating.
07	BCE 4.5 Camera. Complete; operating.
08	MCP-3 (25mm Intensifier) Camera. Complete.
09	Cohu 4410 TV Camera. (2" f.l.) (VHS) Complete.
10	Fairchild T-10 Spectral Ballistic Camera. (150 line grating). Complete.
11	K-6K Ballistic Camera. Complete; checked out.
12	Cohu 4410 TV Camera. (4.5" f.l.) (VHS) Complete; checked out.
21	PE 9/GC Camera. Mechanically Complete. (Req. optional gear set).
22	Cohu 4410 TV Camera. (4.5" f.l.) (S-VHS) Complete.
23	BCD 4.5 Camera. Complete; operating.
24	MCP-3 (25mm Intensifier) Camera. Complete.
25	Cohu 4410 TV Camera. (2" f.l.) (VHS) Complete.
26	K-12W Spectral Ballistic Camera. (300 line grating) (Color). Complete.
27	K-12E Ballistic Camera. (Color). Complete. (In Albuquerque, NM)
28R	K-3P Launch Ballistic Camera. (Color). Complete;operating.
29	K-6D Ballistic Camera. (Color). Complete; operating.
31	PO 9/BCE Camera. Complete; operating.
32	KM-6/BCD Camera. Complete; checked out.
33	MCP-6 (25mm Intensifier) Spectral Camera. (300 line grating). Complete.
34	Cohu 4415 TV Camera. (4.5" f.l.). Complete. (Req. lens change to 4.5").
35	T-6F Spectral Camera. (75 line grating). Complete; checked out.
36R	K-6D Ballistic Camera. Complete; operating.
37R	K-3P Launch Ballistic Camera. (Color). Complete; operating.

R = Remote Site

Req. = Required

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